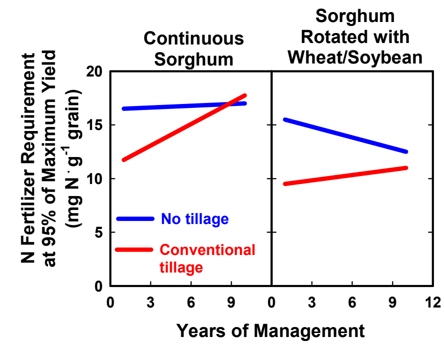
Research Area I:

Nitrogen fertilizer is one of the most expensive monetary and energy inputs in the production of cereal grains. *Recommendations for N fertilizer* in most states are based on data from conventional cropping systems, which include monoculture and clean tillage. N fertilizer recommendations are needed for corn and sorghum in rotation with soybean and forage legumes and for sorghum during transition to no tillage. A simple biological tool to quantitatively estimate N mineralization from soil organic matter is needed.



Nitrogen fertilizer requirements for cereals rotated with other crops can be reduced with time compared with continuous cereals. Also, the accumulation of soil organic matter under no tillage can eventually reduce N fertilizer requirements.

Franzluebbers AJ, Francis CA. 1991. Farmer participation in research and extension: N fertilizer response in crop rotations. *Journal of Sustainable Agriculture* 2:9-30.

Corn (Zea mays), sorghum (Sorghum bicolor), and wheat (Triticum vulgare) producers in Nebraska were active, participating members of the research team that examined crop yield response to N fertilizer in rotations and continuous cereals during 1988 to 1990. Farmers shared ownership of experiments, from interpretation of deep profile soil tests to choice of N fertilizer levels for field comparisons. A research technologist assisted with design of trials and collection of data during the season and at harvest. Data from over 80 experiments were analyzed and results sent back to each collaborating farmer for them to interpret and derive their own recommendations from their trial. At a series of extension meetings, the results were presented and farmers were asked to determine their own N recommendations from the response data. They concluded that continuous cereals would probably respond economically to moderate levels of N fertilizer (50 to 90 kg/ha depending upon expected yield, available moisture, and level of residual soil nitrate. Little or no economic response to N fertilizer was observed when cereals followed alfalfa (Medicago sativa), sweet clover (Melilotus spp.) or soybean (Glycine max). Testing approaches for farmer participatory trials is one key part of our planning for research and extension in the future. This paper describes one successful project with farmers fully involved in the process.

Franzluebbers AJ, Francis CA, Walters DT. 1994. Nitrogen fertilizer response potential of corn and sorghum in continuous and rotated crop sequences. *Journal of Production Agriculture* 7:277-284.

Crop management systems need to be designed to maintain economic profitability and minimize negative environmental impact. The objective of this study was to determine the effects of previous crop, yield potential, and residual soil nitrate (RSN) on grain yield response to N fertilizer of sorghum [*Sorghum bicolor* (L.) Moench.] and corn (*Zea mays* L.). Trials were conducted on 38 farms in 14 counties of eastern Nebraska during 1988 to 1990 and separated by previous crop into three groups, including *i*) cereal [either sorghum, corn, oat (*Avena sativa* L.), wheat (*Triticum aestivum* L.), or rye (*Secale cereale* L.)], *ii*) soybean [*Glycine max* (L.) Merr.], and *iii*) forage legume [either alfalfa (*Medicago sativa* L.), sweet clover (*Melilotus officinalis* Lam.), or red clover (*Trifolium pratense* L.)]. The potential for a response to N fertilizer was described by relating initially available N to yield level (N/Y). Initially available N included RSN to a depth of 40 in., preplant and starter fertilizer N, and NO3-N in irrigation water. Yield level was assumed to be equal to the maximum predicted yield from regression analysis in individual trials. The critical level of N/Y at which 95% of maximum predicted yield was attained without N fertilizer application, was 0.80 lb initial N/bu grain for sorghum following cereal, 1.44 lb initial N/bu grain for corn following cereal, 0.65 lb initial N/bu grain for corn following soybean, and zero lb initial N/bu grain for corn following forage legume. Knowledge of initially available N relative to expected yield for individual fields will help farmers make sound economic and environmental decisions on the need for N fertilizer in continuous and rotated crop sequences.

Franzluebbers AJ, Francis CA. 1995. Energy output:input ratio of maize and sorghum management systems in eastern Nebraska. *Agriculture, Ecosystems and Environment* 53:271-278.

Crop management systems need to be designed to help farmers maintain economic profitability, while conserving external energy resources and farming in an environmentally responsible manner. The objective of this study was to determine the energy output:input ratio of several maize (*Zea mays* L.) and sorghum [*Sorghum bicolor* (L.) Moench] management systems that are typical of eastern Nebraska, U.S.A. Management variables were *i*) nitrogen (N) fertilization, *ii*) previous crop (cereal or legume), *iii*) tillage (none or traditional), *iv*) herbicide (none, banded, or broadcast), and *v*) water (dryland, limited irrigation, or full irrigation). Eleven management systems were delineated from different combinations of the last four variables and compared at different levels of N fertilization. The energy output:input ratio ranged from 4.1 $\pm$ 0.5 in fully irrigated, broadcast herbicide, traditional tillage systems with cereal as previous crop and no N fertilizer to 11.6 $\pm$ 2.5 in dryland, broadcast herbicide, traditional tillage systems with legume as previous crop and no N fertilizer. The energy output:input ratio decreased with the addition of N fertilizer in all management systems, except in fully irrigated, continuous cereal systems. Management systems with legume as previous crop had a greater energy output:input ratio than those with cereal as previous crop. Under dryland conditions with traditional tillage, the energy output:input ratio was greater with herbicide usage than without. Dryland management systems had greater energy output:input ratios than systems with irrigation. The obvious short-term advantage of greater food production from irrigated agriculture using high levels of fossil fuel derived inputs must be balanced against the long-term costs to society of depleting a scarce and non-renewable energy resource. Rotation of cereals and legumes under dryland conditions in the western Corn Belt may be more sustainable for the future based on energy use efficiency because of lower fossil fuel requirements from N fertilizer and irrigation.

Franzluebbers AJ, Hons FM, Saladino VA. 1995. Sorghum, wheat, and soybean production as affected by long-term tillage, crop sequence, and N fertilization. *Plant and Soil* 173:55-65.

Yield decline of cereals grown in monoculture may be alleviated with alternative crop management strategies. Crop rotation and optimized tillage and fertilizer management can contribute to more sustainable food and fiber production in the long-term by increasing diversity, maintaining soil organic matter (SOM), and reducing adverse effects of excessive N application on water quality. We investigated the effects of crop sequence, tillage, and N fertilization on long-term grain production on an alluvial, silty clay loam soil in southcentral Texas. Crop sequences consisted of monoculture sorghum [*Sorghum bicolor* (L.) Moench.], wheat (*Triticum aestivum* L.), and soybean [*Glycine max* (L.) Merr.], wheat/soybean double-crop, and rotation of sorghum with wheat/soybean. Grain yields tended to be lower with no tillage (NT) than with conventional tillage (CT) early in the study and became more similar after 11 years. Nitrogen fertilizer required to produce 95% of maximum sorghum yield was similar for monoculture and rotation upon initiation of the experiment and averaged 16 and 11 mg N/g grain with NT and CT, respectively. After 11 years, however, the N fertilizer requirement became similar for both tillage regimes, but was greater in monoculture (17 mg N/g grain) than in rotation (12 mg N/g grain). Crop sequences with double-cropping resulted in greater land use efficiency because similar or lower amounts of N fertilizer were required to produce equivalent grain than with less intensive monoculture systems. These more intensive crop sequences produced more stover with higher N quality primarily due to the inclusion of soybean in the rotation. Large quantities of stover that remained on the soil surface with NT led to greater SOM content, which increased the internal cycling of nutrients in this soil. In southcentral Texas, where rainfall averages nearly 1000 mm/yr, more intensive cropping of sorghum, wheat, and soybean with moderate N fertilization using reduced tillage can increase grain production and potentially decrease N losses to the environment by cycling more N into the crop-SOM system.